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SYSTEMS AND PRACTICE OF THE DRAFTING-ROOM

CONTENTS

Standard Drafting-Room Methods, by M. R. Kavanagh, E. W. Beardsley, Warren E. Willis, and Julian D. Page 3

General Suggestions in Making Drawings - - - 12

Drafting-Room Kinks - - - - - - - 26

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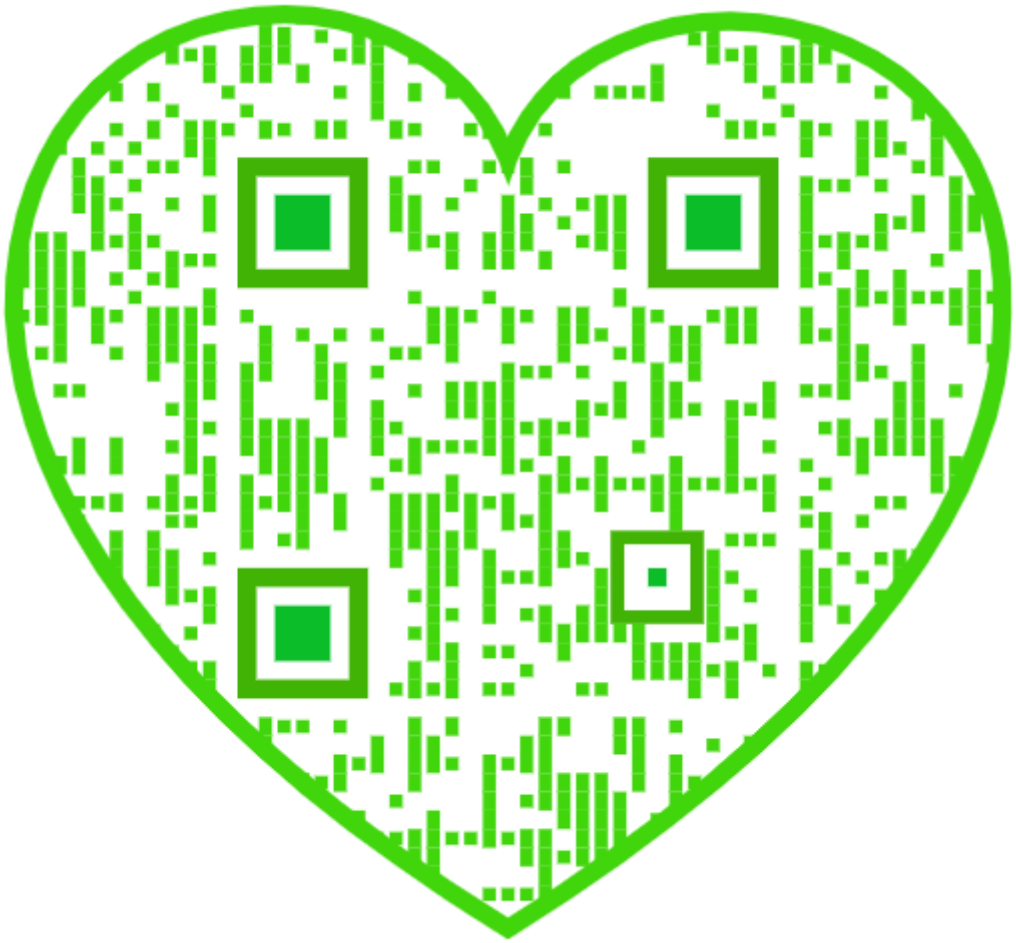

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CHAPTER I.

STANDARD DRAFTING-ROOM METHODS.

The theme of the standardization of methods in the drawing-room is one which is of vital interest to all who are connected more or less directly with this line of work. There are so many leaks possible in the drafting department of any firm, so many ways in which time may be saved by having a way to do things and a place to put them, that a few words upon this topic cannot fail to interest many.

Of course, good light and the least possible amount of noise and confusion in the room during working hours are a foregone conclusion, while the equipment and size of the quarters devoted to this branch of the business must necessarily depend upon the size of the company. Beyond this, however, the way in which the drawing-room ministers to the wants of the factory, and the accuracy and speed with which the drawings are turned out, depend greatly upon the efficiency of the system and the longheadedness of the chief.

About the first step in any good system is the adoption of a number of general rules, governing the production of any new work, which may be easily blue-printed and handed to any new man on his arrival, thus giving him a line on the general way in which the work is desired to be gotten out. These data may conveniently cover such points as sizes of drawings, methods of dimensioning, limits to be used on the work, methods of indicating various finishes, styles of lettering, cross sections, etc. In some drafting rooms they have gone a good deal further than this, and have what may be termed data sheets. These, in addition to the above, comprise a list of the stock of steel in the various sizes, shapes, and qualities, carried by the firm; stock patterns, examples and explanations of the various formulas in use in the shop; and, in general, a collection of data relative to the firm's work, which the draftsman or designer might spend much valuable time in looking up.

On account of the fact that everyone, no matter how careful, will occasionally commit errors, an efficient checking method is essential to do good work. The best method to follow is this: The chief explains to the draftsman, by sketch or verbally, what he desires, and the drawing is made under the supervision of the chief who gives it his approval as regards design. It is then submitted to the superintendent, the chief engineer, or somebody who is in the last instance responsible for results. He either approves it, or orders such changes as he thinks advisable, and the drawing is returned to the draftsman for alteration, if necessary, or, if not, is passed to the checker. The drawing is then thoroughly checked by him for accuracy as to scale, dimensions, and mathematical calculations. If any corrections are found necessary, the drawing is again returned to the draftsman, who

34 818

makes the necessary alterations and returns it to the checker, receiving his approval on same. The drawing then goes to the tracer, who makes the tracing and returns the original and the tracing to the checker. If any corrections are necessary on the tracing, the tracer makes them under direction from the checker, who finally approves the tracing. It is then ready for the blue-print room, and any errors which show up later are held against the checker. This system is very thorough, and the errors that will occur are few and far between.

Another feature of value is the grouping of the various blue-prints covering the manufacture of a certain machine, or a number of machines of similar character, in bound packs or books, located at various points throughout the plant. This obviates the continual replacement of lost prints, which consumes so much time where loose prints are used. Each book is receipted for by the foreman who has the work covered by it in charge, as are also the new prints made necessary by changes in design or dimensions. A record of the location of these books is, of course, kept in the drawing-room, and a man is detailed to keep them up to date. There should be an exception to this rule in the screw machine department, as the prints of the parts should here be mounted on boards and shellaced, the operator having one of these cardboard mounts on his machine where he can refer to it. The mounts not in use are kept in a cabinet for that purpose, where they are easily accessible to the foreman of the department in planning his work. In this connection it might be well to note that all the prints necessary to go into any one department are those referring to operations performed in that particular part of the works, and the drawing-room is generally the only place where a complete set of prints is available.

A good system of handling and recording the changes made on drawings is rather difficult to devise. The following system, however, will prove satisfactory. If the change is a slight one, as for instance the change of a dimension, the tracing is changed, the date of change being noted in the lower right-hand corner, and the various prints are changed by the man in charge of that work. If the design is changed, a new tracing is made, the old one marked obsolete, new prints made and put in the books, and the new tracing filed with the old one. In each case a record of every change is made in a book kept for that purpose, and as the parts are all arranged numerically, it is very easy to refer to this record to find the details of the change in making repairs or filling orders for old parts.

It is remarkable what a number of drawings will accumulate in the course of a few years, when old designs are being constantly brought up to date, and new machines being added to keep abreast of the times. Owing to this fact, it is necessary to have a number of cabinets, with drawers made to fit the different sizes of drawings. In these drawers the tracings are filed, as has been said, according to numerical order. One should also install a card index giving the exact location and size of the drawing of the particular part sought, and in case the number of the part is not known, a cross index to give

an alphabetical classification. As an auxiliary to this index one should have a smaller one in which are grouped such tools as bits, reamers, special drills, counterbores, etc., which is a great aid and convenience to the designers in making up similar tools, or, as often happens, in adapting the old tool to a new part. In most drafting rooms there are, of course, two distinct divisions, one for the design and production of the drawings covering the machines themselves, and one for the design of the tools necessary for the economic production of these parts. In the former department the data utilized can for the greater part be found in the standard mechanical works or the trade catalogues. In the tool designing department, however, the data is mostly compiled from the book of experience, of which there is no authentic edition.

The following general instructions are intended to be, for the most part, or with minor changes, applicable to the practice of the average drafting room, and, for that reason, are usually confined to principles. Disagreement will often be found with those which are not principles, but they represent excellent practice. They are condensed as much as possible into a few words, as the object has been to state them so concisely that it would require but a few minutes to hurriedly read the whole and to thus make it easier for a beginner to read them every day, or for a checker to glance them through, occasionally, for pointers that might have slipped his mind.

Scale.

Make details to a scale large enough to distinctly show all parts and also to give sufficient room for necessary dimensions. This will sometimes require two or more times actual size. Do not use an unnecessarily large scale when it will also require a larger sheet than is otherwise required.

As to scales, there are more in use than desirable or even necessary, and the use of an odd scale should not be tolerated, notwithstanding the claim made that the use of scales not common prevent scaling the drawing by workmen; but others besides machinists may want to "check up," and then it becomes awkward, to say the least, especially if that particular scale is not at hand.

Occasionally drawings will be noticed bearing the phrases, "Do not scale," "Work to figures," "Report all errors to this office," etc. All this seems useless, for general rules and common sense indicate this as clearly as words can do it. It is an insult to the intelligence of the workmen on the part of the draftsmen to try to indicate to him that which is clearly obvious.

Views.

The views required are those necessary to completely and plainly show the piece—no more, no less—except that one view is sufficient if another would show no more than is given by "4 inch dia.," "¼ inch thick," etc., on the one view.

Show pieces in the position they occupy on the construction drawing or on the completed work, when there is no disadvantage in doing so.

Do not leave wider "open" spaces between the several views of one piece than between those and the views of nearby pieces. Do not crowd views so closely together that there will not be sufficient room for dimensions and notes.

Show long pieces with a portion of the length broken out, when a larger scale is desirable than could be used if the full length of the piece were shown; but do this only when a continuous portion of parts fully shown is thus broken out, or when notes fully explain the cmitted portion.

A part of a view may be shown when the remainder would be only a repetition of what is plainly shown elsewhere.

Always use "third angle" projection; that is, place views nearest the side of adjoining view which they show. Follow the same principle of direction of view in sections, making them on the side where the outside view of the cut-away portion would be. Any deviation from this rule must be very plainly noted on the drawing.

Always draw both right-hand and left-hand pieces when both are to be made, unless the differences are so simple that one or two dimensions can be noted for each without confusion. If the pieces are castings, and but one pattern is required, make notes to that effect, mentioning changes. This also applies to similar pieces cast from one pattern with changes, when a detached view, or portion of one, would often show the change.

Lines.

Make outlines in medium or heavy lines, giving strong contrast with dimensions and center lines, which must always be light but distinct.

Make section lines not less than 1/16 inch apart, except on widths of less than ⅛ inch. Make them lighter than the outline. On ordinary work, narrow sections may be cross-sectioned by free-hand.

Have no "hair" lines in figures, letters or outlines.

Dimensions.

Give all the dimensions necessary to make the piece—no more, no less—and do not repeat them on same nor on different views of the same piece unless for a special reason.

Give dimensions so that the workman will not have to do any important figuring himself.

Give dimensions where and as they will be most useful to the workman.

Do not give dimensions from the center line of a piece when it is not necessary.

Give dimensions from something that the workman can and should measure directly from, if reasonable to do so.

Give dimensions between places having a definite relation rather than otherwise.

Place the shorter dimensions nearest the outline.

Place dimensions so that there need be no doubt as to what they refer.

Do not repeat a dimension many times in a single line where the

likeness is clear from the drawing. At most, give it two or three times and then include the remainder, or the whole, in a dimension reading like this: 12 spaces at $9'' = 9' - 0''$.

Never crowd dimension lines or figures.

Run the limiting line slightly beyond the end of the dimension line.

On a piece having several diameters in its length, or in similar holes, give the diameters in the side view, or section, rather than in the end view.

Where two things are centrally spaced in relation to a third, and also definitely related to each other, give one dimension from the center to one and another between the two.

Where an inside dimension is given on an outside view and is not much different from it, make distinct by marking "inside," or by giving, in line with it, the remaining dimension.

Do not call for impossible or unnecessary accuracy. If a dimension is calculated 18 1/64 inches and the work is so rough that inaccuracies of 1/16 inch are provided for, leave off the 1/64 inch, but do not disregard the correct figure in further calculations.

Give angles from existing surfaces, or, so that no figuring will be required of the workman in order to measure the angle.

Make the dimension line for an angle an arc with its center at the vertex of the angle. Mark figures "deg." and "min." Do not use their signs.

Mark radii "rad." or "R."

If it is generally understood that all sizes are given in inches and fractions thereof, up to a certain definite number, like 100, the inch mark (″) may well be neglected as time taking and obscuring to the drawing. On 6's and 9's some prefer to use them for the sole purpose of indicating the position they are to read from. Plain Arabic figures, the fractions smaller than the integers, are preferable in making a clear drawing.

Figures and Signs.

Never put letters, figures, signs or arrow-heads on, nor running into, each other, the outline of the piece, nor any but their own dimension lines.

Make figures and lettering read from the bottom or from the right-hand end of the sheet, always parallel with one or the other, except dimensions on lines necessarily on an angle, and on radii, and angles dimensioned in degrees, which may read on an arc of the angle.

Make figures and letters large enough and heavy enough to be distinct—not less than 5/64 inch or 1/12 inch high on ordinary work. That size for fractions, and 1/8 inch to 5/32 inch for whole numbers is good practice.

Make the dash between feet and inches distinct so that $3' - 4''$ shall not be mistaken for 34″.

Make arrowheads plain and neat. Make them blunt if there is danger of doubt as to the line they designate.

Use open and distinct forms of figures and letters.

Make inch and foot marks distinct, but much smaller than the figures.

Make whole numbers given together with fractions large enough that they will not be mistaken for a part of the fraction.

When the space is not necessarily limited in height, use the horizontal vinculum, or separating line in fractions: $\frac{1}{2}''$ rather than 1/2".

Notes and Lettering.

Put notes on the drawing whenever necessary for a distinct understanding of the requirements, as when one part is to have a certain fit with another, except where the same is otherwise provided for, as by gages, micrometer measurements, etc.

Express things in notes whenever they will be plainer that way than by further drawing or dimensions.

On rough works it is often well to note character and use on size of holes thus: "drill 17/32" for ½" bolts," "punch 9/16" for ½" bolts," "core ⅝" for ½" bolt," "ream for ½" shaft," "bore for sleeves No. 65."

When there might be a question about them, mark cast holes whether cored or cut in pattern.

On work having little finishing, mark such surfaces finish, bore, drill, turn, etc.

Run leading lines from notes to holes or other features to which they apply, unless their relation is very plain. Make them free-hand, light, with black ink and an arrowhead at the end indicating unmistakably to what they refer.

Avoid all words and phrases which might be easily misunderstood, or not understood at all.

When a note consists of more than two lines, make them match, vertically, on the left-hand side.

Make spacing between lines of lettering in notes uniform and not wider than the height of the letters.

Except in simple cases, name the sections of a piece and show by a light broken line where they are taken. Letter the ends of the line to read from the side that would be removed to show the section as drawn.

Make all lettering in capitals, vertical, or very slightly inclined to the right, and of uniform height.

Make titles, names of sections, views, and pieces, with letters ⅛ inch high, other lettering 1/12 or 5/64 inch high.

Such statements as "one thus," "one of this"—both of which are actual prevarications—should be abolished as time-taking nonsense. The number of pieces required may be given simply in connection with the material to be used, and the name or number designating the part shown, and nothing more is required. This had better be written, rather than given in numerals, to prevent any possible error.

The general title—as the name of the machine, the parts actually shown, or the word "Details," the party for whom the drawings are made (if other than the makers), and the engineering office making them—should be given. If likely to be sent away, and hence become "foreign" drawings, the address may also be added.

Symbols and consecutive filing numbers should be sufficiently large

so as to readily catch the eye; in fact, they should be the most prominent thing about the sheet, and it is not a bad plan to have the same repeated on the opposite corner in case the drawing should be turned bottom up.

General Rules.

Exercise your "gray matter" a little before doing things rather than "the boss's" patience afterward.

A rule is sometimes better observed in the breaking rather than in the keeping. Heed the spirit as well as the letter of all instructions.

The men who make the pieces are not draftsman and should not be supposed to know more about a piece than is given on the drawing.

A drawing is plainer to the man who makes it than to the mechanic who first sees it when he just starts on the work. Consider what you would want to know if you were to make the piece correctly under the workman's circumstances.

Strive for clearness, completeness, simplicity and neatness.

While it is admitted that drawings are not in themselves an end, but rather a means to an end, it is equally true that they constitute a sort of universal language in mechanics, and the more perfect and uniform this language can be made the better it must be for all concerned.

Summarizing, and putting our instructions in the most concise form, we may formulate the following exact rules for general drafting-room work:

All drawings should be made on standard size sheets, within standard borders; full size, or to as large a scale as possible.

All views should be placed in the third angle.

Views should be so arranged on the sheet as to leave a clear space for the title at the lower right-hand corner.

Shade lines, *i. e.*, heavy lines drawn on the right-hand and lower side of solids—oppositely on interiors—should be used.

Shading, excepting at the intersection of cylinders, is not desirable.

Use section lines as little as possible.

All figures to be at least ⅛ inch high and clear of view.

All sizes less than 100 inches to be in inches.

No inch marks should be used, except on the 6's and 9's, when alone.

The oblique line between the members of a fraction should not be used whether the fraction is in connection with an integer or stands alone.

Center lines should be made in thin black.

Dimension lines should be made in thin black.

Titles should indicate, (a) the object drawn; (b) for whom or for what purpose; (c) name of engineering office; (d) scale used; (e) date; (f) draftsman; (g) checker; (h) number of drawings in set; (i) individual number of drawing; (j) symbol; (k) numerical order of drawing; and when desirable, (l) designer; (m) size of sheet, represented by symbol; (n) if detail or assembly, and (o) by whom approved.

Checking a Drawing.

In checking drawings for a machine, the first thing to be done in all cases is to get the general arrangement, and to check the center distances and elevations with the principal dimensions given on the details. After the principal dimensions on the general drawing have been checked, it is used as a lay-out for the details. Each dimension on the detail is checked, and if a similar detail has been used on some other machine, in order to establish a standard, the new one should be made proportional to the old. Finish marks are noted on details where required, and none on surfaces that do not need it, for any finish that can be saved lessens the time in the machine shop. Sizes of all bolt holes are marked and the bolts to be used are called for or noted. Every piece on the drawing, either called for or shown, must be given a letter or pattern number, and the number of pieces required for each drawing ordered. If a certain radius for curve is used in one place, the same radius should be used in each similar place. Care must be taken in checking that standard sizes are used as far as possible, especially in slots for bolt heads. If a slot is made so wide that a standard square head bolt turns in it, a special bolt is required; while if the slot had been made narrower, a standard bolt from stock would have answered the purpose just as well. Whenever practicable, the pieces of a machine should be made so that one can be removed without disturbing the other, this saving a great deal of time when making repairs. As few patterns as possible should be made, and often, with a little foresight, one pattern can be made to answer in two or three places by making some pieces loose so that they can be changed around to suit different conditions. Great care must be exercised that there are no interferences. These can best be detected on the general arrangement and by laying out the adjacent machinery.

In most drawing-rooms, when checking, the tracing is used, and all the changes are noted on the tracing with a pencil—blue, red or black, as the draftsman prefers, while the correct figures are checked with ink. After the man who made the drawing has approved the indicated changes, the tracer makes them without erasing the pencil marks. The drawing is then returned to the checker, who checks off the changes that have been made. As he checks them off in ink, he cleans the tracing with a sponge rubber and anything the tracer may have missed the checker finds during this operation. All figures on the drawing must be clear, so that there can be no doubt in the shop as to the intended dimensions. The pattern and drawing numbers must be looked up to see if the records have been made out properly, and after the detail drawings are all checked the general drawing can be finished. All the pattern numbers are noted and the principal pieces marked with their particular mark and drawing number.

It is, however, a much easier and better way to take a print of the tracing to be checked. All corrections or changes are indicated on

this print with red pencil, and all figures that are right are checked with yellow pencil. The changed blueprint is given back to the draftsman and he and the checker go over it and decide which is the correct figure or the better way to do the work. After all changes have been approved, the tracer makes the corrections indicated in red pencil. When this is finished the checker compares the tracing and the blueprint to see if all changes have been made and if he finds the dimensions on the tracing correspond to the red ones on the print, he checks those on the print with a blue pencil, marks the tracing "checked," and the checked blueprint is filed. If the work does not go together properly in the shop, the chief draftsman can produce the checked blueprint, see if the dimensions have been overlooked or improperly checked, and so know where to place the blame. When a drawing is checked by this method no check marks show on the tracing, but it is marked in one corner: "Checked by ——," and the date given when checked.

With the first method it is not unusual for a drop of ink to fall on the tracing or for some of the check marks to be blurred. The checker must then spend quite a little time in cleaning off the drawings, a waste of labor which is obviated by the latter method. If there are a large number of drawings for the machine, the tracings in the first method get very badly soiled and crumpled, it being necessary to have them all on the table during the entire process of checking, which often occupies a week. In the latter method, however, the tracings are out only while the tracer is making the necessary changes and while the checker looks them over to see if they are correct.

The following concise rules for checking drawings may prove of value to inexperienced checkers: See that the parts are strong enough to do the work. See that they are of the proper materials and that all the dimensions are drawn to scale and check up with each other. Care should be taken that the proper number of pieces of each part for one machine is called for on the drawing. The different parts should be so designed that the machining may be easily done with the facilities at the disposal of the establishment, and finish marks should be carefully checked to see that some parts are not marked to be finished which should be left rough, and *vice versa*. There should be, also, a correct list of the subsidiary but necessary articles to be drawn from the store house or ordered outside, as, for instance, oil cups, nuts, wrenches, and bolts.

Each part must be so designed that it may be readily removed for inspection or be easily accessible for cleaning and repairs. If the part is heavy, facilities should be provided for handling it, and some parts, such as cylinder heads, should have starting screws by which they can be given the preliminary lift from their seats. All moving parts should be furnished with lubricating devices so located that filling and cleaning may be easily attended to, and with oil passages so disposed that the lubricant will easily reach the surfaces for which it is intended.

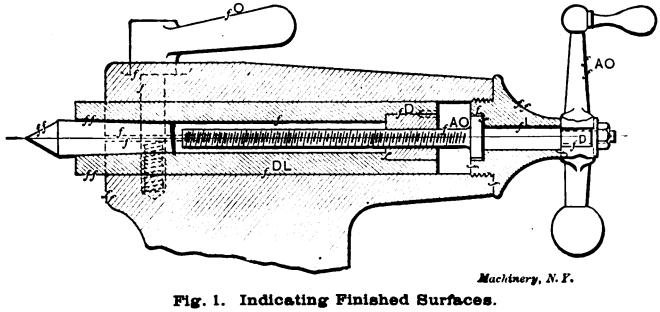
CHAPTER II.

GENERAL SUGGESTIONS IN MAKING DRAWINGS.

Indicating Finished Surfaces.

Fig. 1 shows a simple and convenient system of finishing marks which has been in use in a well systematized drafting room for several years. It will be noticed that the usual *f* is the predominating character, with the addition of another letter at the right, this letter denoting the fit desired in the piece on which it may be placed. This exponent, as it were, has not been chosen so much because it would suggest the character of the fit, but rather for the ease with which it may be made on the drawing, that is, with one stroke of the pen. In the design of special machinery, where the workmen have no past experience to guide them, these marks have saved, to the draftsman, any small and yet important questions as to fit, finish and quality of finish, necessary.

On detail drawings, something to show the fit is essential to make a



Machinery, N. Y.

Fig. 1. Indicating Finished Surfaces.

complete working drawing, and on more or less assembled drawings some marks of this nature are of no less importance, for each man having occasion to use the drawing can tell at a glance what should be a running fit, what a driving fit, what ordinary machine finish, and what polished. The allowance for the fit is preferably made in the holes, the parts fitting them being machined to the exact figure given. This, however, is unimportant, as the allowance could be made on the parts fitting the holes, according to the individual shop practice.

The following table will give a clearer idea of the application and value of the marks. If each man is given a blue-print or card of the finish characters along with the first drawing on which they are used, no further trouble is found in making the men accustomed to their use.

Table of Finishing Marks.

The following marks will be used on drawings to indicate the finish and fits required:

f, machine finish.
ff, machine finish, (polished).
f^{O}, hand finish only.
f^{S}, forcing fit, — 0.002 for first inch and 0.001 each additional inch.
f^{D}, driving fit, — 0.001 for first inch and 0.0005 each additional inch.
f^{DS}, easy driving fit; exact size.
f^{L}, running fit, + 0.001 for first inch and 0.001 each additional inch.
f^{1}, finish exactly to size.
GD, gear distance.
+ or —, allowance between shoulders.
→ key drives this way.
f^{AO}, finish all over.

All allowance for fit to be made in holes. Shafts to given dimensions. All dimensions in inches up to 8 feet.

In Fig. 2 is shown another system of finishing marks which has

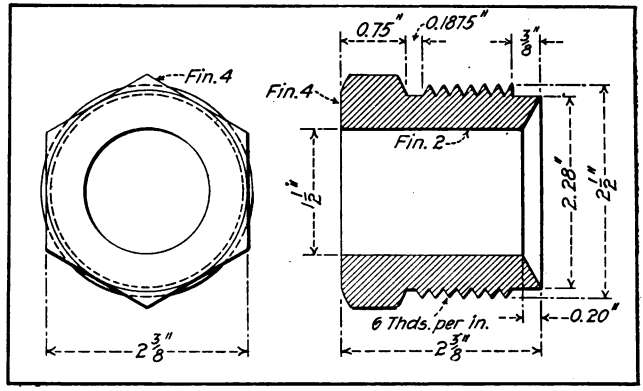


Fig. 2. System for Indicating Finished Surfaces Applied to a Drawing.

also been in practical use for several years in another well-organized drafting room. In this system the various classes of finish are designated by number, as follows:

Finish No. 1 requires surfaces to be extremely smooth and accurate within a tolerance of ± 0.0005 inch.

Finish No. 2 requires surfaces to be very smooth and accurate within a tolerance of ± 0.001 inch.

Finish No. 3 requires surfaces to be smooth and accurate within a tolerance of ± 0.003 inch.

Finish No. 4 requires surfaces to be accurate within a tolerance of ± 0.005 inch.

Finish No. 5 requires surfaces to be rough machined or filed to within a tolerance of ± 0.025 inch.

Finish No. 6 requires that castings or forgings be cleaned of all sand, scale, risers, fins, etc.; and that no thickness of metal when ready to assemble shall differ from drawing dimensions more than ± 5 per cent.

All allowance for fit is to be made on the female parts. Male parts are to be made to the standard size.

With the above system, used on drawings as indicated in Fig. 2, work can be laid out to any degree of accuracy required and the workman readily knows between what limits of accuracy he must make any dimension. In cases where the piece can be made satisfactorily with one grade of finish all over, a note may be added to the name, etc., of the piece on the drawing to that effect. For example, the specification: Washer—Finish No. 4, attached to the drawing of a washer would indicate that no dimension need be worked closer than ± 0.005 inch to the specified sizes.

Recording Changes on Drawings.

The recording of changes or revisions made on drawings of any kind is of the greatest importance, and Fig. 3 illustrates a very satis-

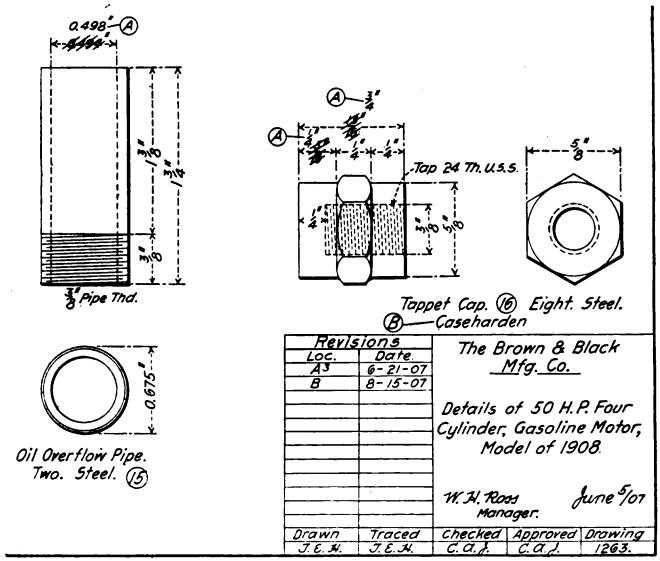

0.498"
A
3/8" Pipe Thd.
Oil Overflow Pipe. Two. Steel. (15)
0.675"
Tap 24 Th. U.S.S.
Tappet Cap. (16) Eight. Steel.
(B)—Caseharden
Revisions
Loc. | Date.
A3 | 6-21-07
B | 8-15-07
The Brown & Black Mfg. Co.
Details of 50 H.P. Four Cylinder, Gasoline Motor, Model of 1908.
W.H. Rood Manager.
June 5/07
Drawn | Traced | Checked | Approved | Drawing
J.E.H. | J.E.H. | C.A.J. | C.A.J. | 1263.

Fig. 3. Method of Recording Changes on a Drawing.

factory method of recording changes on a drawing. The columns headed Revisions show the location on the drawing of dimensions revised and also the date when the revisions were made. The small figure at the right of the letter of revision in the column indicates how many places on the drawing the revision affects. For instance, the revision A^3 affects the drawing in three places, while *B* affects it in only one place, as shown. It is a matter of opinion as to how to remove the old dimension and place the new dimension in its place, but it is preferable that the old dimension be merely crossed out and the new dimension be shown above it, as in Fig. 3.

It is advisable, on account of its simplicity and the possibility for ready reference, that a separate file of revision records for each type

of machine being manufactured be kept. A card system, of some such form as shown in Fig. 4, is preferred by the writer, because its flexibility allows for sufficient expansion to cover all details concerning any revision that may be made in any drawing. The cards in the revision file are indexed by the drawing numbers, and are arranged in their several indexed spaces in the alphabetical order in which the revisions were made. By the above method a complete record of all changes, on any piece, shown on any drawing and belonging to any machine, can be kept in compact form and in condition for immediate reference at any time.

Changing Drawings Quickly.

Occasionally a big change in a drawing is necessary, and a print is wanted at once, or a different style of machine is to be made, having the major portion exactly the same as shown on the same previous drawing. The engraving, Fig. 5, illustrates this case. A rapid method for changing drawings is as follows: A tracing shown at *A* is on

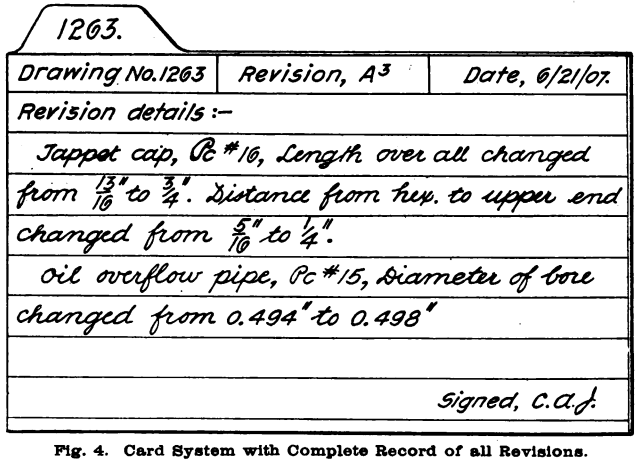

1263.
Drawing No. 1263
Revision, A3
Date, 6/21/07.
Revision details:–
Tappet cap, Pc #16, Length over all changed from 13/16" to 3/4". Distance from hex. to upper end changed from 5/16" to 1/4".
Oil overflow pipe, Pc #15, Diameter of bore changed from 0.494" to 0.498"
Signed, C.A.J.

Fig. 4. Card System with Complete Record of all Revisions.

hand, but we wish a print showing this valve with a female pipe thread on both ends. From this tracing we then make a negative, shown at *B*, using a brown process paper. Now with a piece, or pieces, of brown opaque paper cover up all parts of this negative, *B*, that should not show on the required print. From this partially covered negative make a new print, *C*, again using brown process paper. On this new print, *C*, draw with india ink the special part of the new style valve and use the drawing *D*, thus obtained, as an ordinary tracing. The brown lines will print as well as the lines added in India ink.*

Other Time-Saving Methods for the Drafting-Room.

It frequently happens that the drafting room in a large plant gets behind in its work, and the shop requires drawings at once. It is not always advisable to send out pencil drawings, because, if there is to be

* Howard D. Yoder, Wadsworth, Ohio, October, 1907.

any record kept of the work done in the drawing room, a copy of each drawing should be made before sending it out. Besides that, pencil drawings get mighty greasy and torn knocking around the shop or field. This not only makes it difficult for the workman to understand, but when it is finally returned to the drawing room, tracing it satisfactorily is not possible.

A quick and sure way to solve this problem is to trace the sheet upon tracing paper with a soft pencil. By making the drawing on the tracing paper, not only time but material is saved. This can be done in about one-third the time in which the drawing could be traced upon cloth. Care should be taken, however, to make the lines heavy, so that they will print well; curves and circles can be inked in more quickly and greater satisfaction be given than if they be put in pencil. If

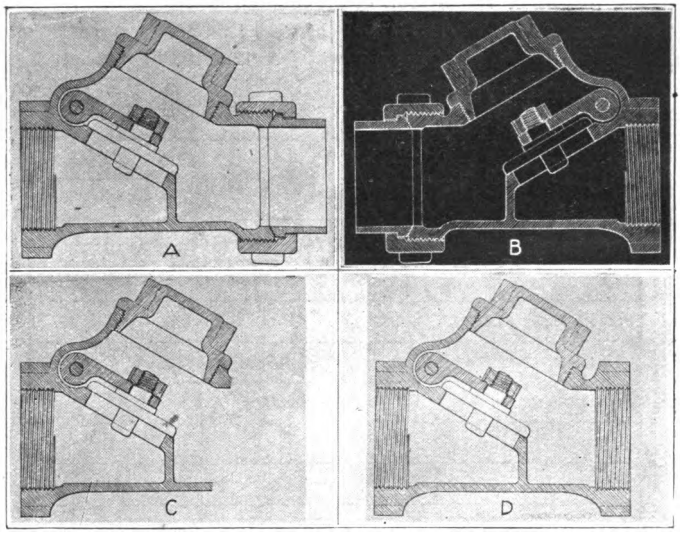


Fig. 5. Method of Changing Drawings Quickly.

strips of drawing paper be pasted on the edges of the paper, it will not tear.

A good method for sending out copies of small or detail work is to have a cross section sketch book about seven and one-half inches by ten and one-half inches. Next to each cross section page should be a number of thin blank pages, preferably three. After the sketch has been drawn in lightly, carbon paper can be inserted between the sheets and the sketch gone over with a glass point or hard pencil. Then these carbon copies can be torn out and sent to the shops, the cross section page being kept for record. These books are handy alike for reference and filing.*

Using Bond Paper Instead of Tracing Cloth.

Thin bond paper is in many respects better than tracing cloth for drawings to be blue-printed. It permits the making of a neat-looking

* F. R. Steuart, Sparrows Point, Md., August, 1906.

drawing, pencil drawings can easily be made on it, a heavy pencil drawing will blue-print nicely from it, and it is cheaper than cloth. Besides, tracing cloth does not lay in drawers as well as bond paper. When tracings are creased across the lines of the drawing it makes it very bad when the print is taken. There is no trouble on this score with bond paper, and if for no other reason than this many have decided in its favor. Drawings can be inked more accurately by inking the original pencil drawing than by tracing, and it can be done more rapidly, which is another advantage for bond paper.

In many drafting-rooms, with the exception of drawings that must be repeatedly and frequently blue-printed, they make no tracings. Such as they make are made largely for the reason that they blue-print more rapidly. Another reason for tracing is, that if the original drawing were used to blue-print from too often, it would soon become worn out and unfit to make another copy from without much labor. So, for standard erecting plans, etc., it is preferable to make tracings on cloth and keep the original carefully, as in the course of years it is likely to need alterations.

From smooth and semi-transparent drawing paper one can get a first-class blueprint in about two and one-fourth times the number of minutes required for tracing on cloth. The drawing is laid out in pencil, then the useless lines wiped off with a piece of "artgum," which is about half-way between stale bread and velvet rubber in its cleansing properties. It leaves the surface in good shape for inking, and when the drawing is inked it is done. There is no tracing to be made.

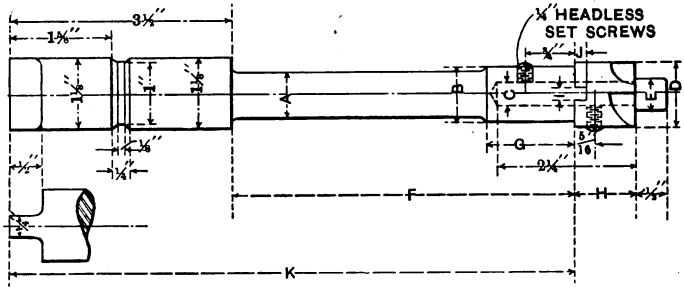
Sketching Methods.

For sketching, there are two good methods of duplicating, and which one is used depends generally upon the number of duplicates required. In case but one or two are needed, make the sketch on fairly heavy cross-section paper with "Mephisto" colored copying pencils. The original sketch goes into the shop in this case, after being copied in an ordinary letter book with moistened pads. A second copy can be made on a loose sheet to send off in a letter if needed, but in case a second shop drawing is likely to be needed later, the other method should be used. This consists of a sketch made on thin cross-section paper with a stylographic pen loaded with Higgins' Eternal ink. This ink has sufficient body to yield a fair blue-print, though it is not thick enough to clog the stylo. If a more elaborate sketch is required than a rough free-hand sketch, lay it off in pencil and then go over the straight lines with the stylo, and the circles and arcs with the regular bow-pen or compass, which is much easier than trying to follow a true curved line with the stylo held in the hand.

From these stylo sketches a very good blue-print can be made, and working drawings put in shape for the shop in a very short time. The sketches are filed in indexed envelopes, and the copybook sketches in colored pencil are all indexed in the back of the book, so in either case it is not much of a job to locate an old sketch.

While it is well to make drawings and sketches fairly complete as

to minor details, at the same time a liberal use of the English language legibly written on the same sheet with the sketch goes a long way to prevent misunderstandings. If draftsmen themselves cannot all agree as to what a certain view of a drawing really represents (and such cases have been spoken of more or less in the technical papers), is it any wonder the man in the shop sometimes has to scratch his head more than twice to see things as the draftsman wants him to? Of course, a written direction can sometimes be read differently by two men, each giving it a meaning of his own, but if the sentences are clear



No.	A	B	C	D	E	F	G	H	I	J	K		
1	¾"	¾	5/16	¾	⅜	4		1	3/16	3/16	7½		
2	¾	¾	5/16	⅝	5/16	4		¾	⅛	⅛	7½		
3	¾	⅞	⅜	1	⅜	4	1⅜	1	3/16	3/16	7½		
4	1¼	1⅜	½	1½	⅝	4	1⅜	1¼	¼	¼	7½		

Machinery, N.Y.

Fig. 6. Example of Tabulated Tool Dimensioning.

and concise, as all technical writing should be, there is not much chance for trouble here.*

Tabulating Dimensions of Tools.

Fig. 6 shows an idea which will be very acceptable to all tool designing rooms, and also to all regular drawing rooms making tool-room drawings. The foreman of the tool-room wants sketches of a number of sizes of counterbores, having various sizes of pilots, and all fitting the same spindle. To save time in drawing, tracing, and blue-printing, rule up a sheet, as shown in the engraving. All dimensions which are constant, are given in their proper places on the drawing itself, while all those which differ for different sizes are indicated by letters, and tabulated. Vacant columns are left in the table of dimensions, and the tool-maker foreman can now supply the required figures for any

* E. R. Plaisted, Montpelier, Vt., December, 1906.

new sizes he wishes to make, and turn the print over to his workman without waiting for another sketch. This idea can be used for a great variety of tools and fixtures, and we find it a great saver of time.

A system that in some respects is even better than the one mentioned above is in use in some drafting-rooms. Instead of inserting letters for variable dimensions and tabulating them, the spaces where the variable dimensions are to be given are marked on the tracing with circles filled in with india ink, thus producing on the blue-print a white spot on which the dimensions can be conveniently and plainly filled in with ink. The work of filling in the dimensions on the various blue-prints is hardly more than that of tabulating; but the advantage gained of having one distinct blue-print for each tool aids greatly in preventing mistakes in the shop, due to reading the dimensions wrong in the table.

Method of Enlarging or Reducing Drawings.

Very often it is desired to reduce or enlarge drawings, scroll designs, letters, maps, etc. This can be done to scale or by proportional dividers, but perhaps the simplest and quickest method is as shown in Fig. 7.

The only dimension necessary to lay off is the distance shown at *A B* which of course is the dimension desired for the reduced or enlarged copy. Fig. 7 shows the method for reducing which also applies for enlarging. It will be noticed that large and small rectangles are drawn with a diagonal line through each, and to these lines points are projected, and from there to the space where the copy is desired. The intersection of these lines are points of the copy.

Fig. 8 shows line *C* reversed from that shown in Fig. 7, which causes the copy to become reversed. This is especially convenient where it is desired to obtain a right and left view of any object. In making the third view of an object when detailing it is more convenient to plot it as shown in Fig. 9 than by the usual method of scaling each dimension as it can be done much quicker and with less chance of error. The diagonal line should of course be at 45 degrees in this case. In actual use, dashes cutting the diagonals are sufficient, instead of the construction lines shown in the engravings.

Titles and Border Lines on Drawings.

To be complete, a title for a drawing should include in order of importance:

1. The name of the machine to which it belongs.
2. The shop symbol for the machine, if any.
3. If not an assembly of the whole machine, the name, if there is a commonly used one, of the principal parts shown, as:

16-INCH ENGINE LATHE,
COMPOUND REST.

4. The words

Assembly,
Assembly Detail,
Details,

according to which it is.

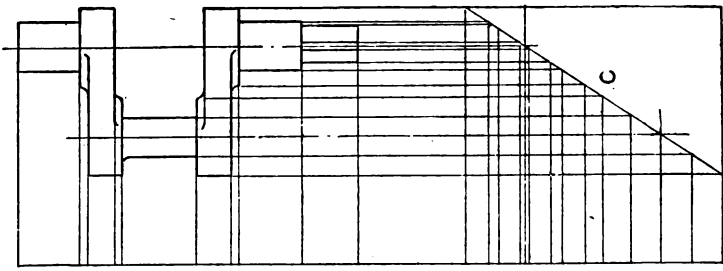


Fig. 8. Obtaining a Left-Hand View from a Right-Hand Drawing.

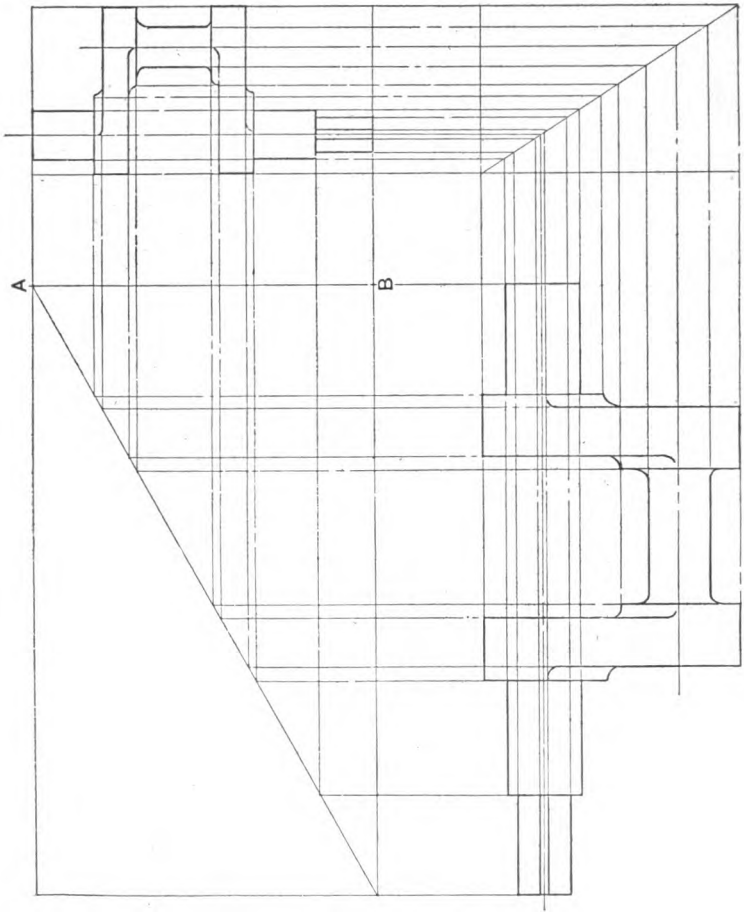


Fig. 7. Method of Enlarging or Reducing Drawings.

5. Name of firm.
6. Date when finished.
7. Name or initials of designer and draftsman and any other person who is responsible for the drawing. The first five items above must be drawn in heavy type, large enough to be instantly read. The last two will meet all requirements if they are simply legible.

Where parts are numbered or lettered, it would be a great convenience if alongside or just over the title, on a detailed drawing, a list of the parts which are shown on the sheet were given.

The length of time to be allowed for making the title and border lines depends, one might say, on about the same condition that a man's dress does. Border lines correspond to collars and cuffs and title to clothing in general. So we would no more leave a drawing without a title than we would go naked; but on the other hand, for shop use we would hardly dress our drawing up as for a reception. So for shop

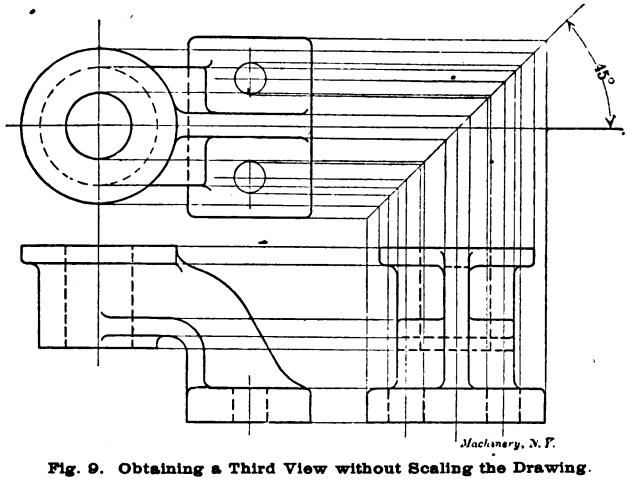


Fig. 9. Obtaining a Third View without Scaling the Drawing.

drawings, leave out border lines altogether and put in the title off hand, being certain that it is clear and legible and always in the same corner of the sheet as the drawings lay in the drawer. But if the drawing is going out to help sell a machine, have a neat, clear title and a plain, medium border.

Pattern-Makers Blue-Prints.

There is a chance for improvement in most drafting-rooms over the method which is in vogue regarding furnishing the machine department with a print containing many dimensions which do not in any way concern it, but which are used by the patternmaker only. When the pattern has been made and castings made from it, and finally, when the machine is finished and no alterations are to be made on the pattern, the pattern dimensions should be omitted from the machine shop print. It is sometimes customary to make two tracings to accomplish this if the piece is complicated, such as machine beds, etc., but

the following method has the advantage of requiring but the one tracing. A finished tracing is made containing all dimensions both for the patternmaker and machinist. The dimensions for the machinist are inked in as usual, but the pattern dimensions are put in with a soft lead pencil. Several prints are taken from the tracing while in this condition, one furnished the pattern shop and as many filed away as desired. The lead pencil dimensions are then erased and the tracing is ready for making prints for the machine shop. In this way the patternmaker can readily understand and pick out his figures, and the machine shop print is kept free from unimportant dimensions which ofttimes cause considerable trouble.

Making Blue-prints from Typewritten Originals.

It is possible to make good blue-prints from typewritten originals, if one prepares the original properly. What is desired is a sharp, black copy that will make a good, clear blue-print, and the method of making these originals is as follows:

Upon a sheet of copy paper such as used for manifolding, lay a sheet of carbon paper face up; take a piece of tracing paper and lay it on the carbon paper and put them in the typewriter in this order so as to write on the tracing paper. This will give a copy on the front and back of the paper that will be strong enough to take blue-prints from if the following is closely observed. A good black ribbon is required, a new one if possible, but do not use one that has been used for any length of time and that will not strike up a good sharp black letter; a good carbon paper is also required. Use a new sheet every time, so as to get a good uniform letter; the carbon sheet can then be used on regular manifold work so that nothing is lost by it. The paper used for backing is the regular copying paper used for manifolding, but this is immaterial and can be made to suit different machines. The best paper for the original is a good tough grade of thin tracing paper, such Keuffel & Esser's "Series" brand, which takes the ink and carbon well and from which mistakes are easily erased without damaging the paper. As regards carbon paper that will give a good black uniform impression, the "Pilot" brand from the United Carbon Company suits this purpose exactly.

In making erasures, use a soft rubber, as an ink eraser will rough up the surface of the paper, and when the character is struck over, it will smut. To correct mistakes, turn up the paper and place at the back some smooth object (say a piece of glass or a celluloid triangle) and erase on the face, then place it on the face and erase on the back; the desired character can then be struck in.

Two photographic reproductions, slightly reduced, are shown in Fig. 10 of a small typewritten original, front and back, and the fact that it reproduces in this manner clearly is a guarantee that it will blue-print well, provided the writing is done on transparent paper such as any good tracing paper or cloth.

To Make Blue-prints from Heavy Drawing-paper Originals.

Oftentimes a draftsman finds it advisable to make blue-prints of cuts and drawings of which he may have a copy on printing paper or

heavy drawing paper, etc. This is a long and tedious operation if conducted in the usual manner, but if the sheet to be printed is first given an application, or "coat," of gasoline or benzine, on the face side, and then printed, the result will be better and more quickly obtained than in the ordinary way.

The benzine will evaporate very quickly and leave the original in as good a condition as before the print was taken. Care should be taken that too much benzine is not used as it might spot the original if the blue-print solution were to be reached by any great quantity of benzine. The writer has, however, never experienced this difficulty, although many prints have been made by this method.*

Patching Drawings.

It is the opinion of a great many draftsmen that one can obtain a more accurate drawing in less time with a good grade of bond paper (say "crane" or any other good bond, about No. 18), than on tracing cloth; and if bought in large quantities the maker will tint this paper a soft color that is pleasing to the eye. The drawing is inked in on

This is a sample and is on "Series Paper"
ABCDEFGHIJKLNMOPQRSTUXVWXYZL:?.!
abcdefghijklnmopqrstuvwxyz;,.-
1234567890"#$%_/.°^*¢£+×@=)('&_%

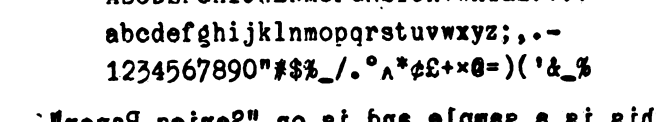


Fig. 10. Reproduction of a Typewritten Original.

this paper and good blue-prints can be made from it. When making a drawing upon which a great deal of time is to be spent, such as the design of a new machine, the paper is dampened and the edges are glued to the drawing board. When dry it presents a surface which is smooth and which is not affected by any atmospheric changes and moisture that buckle and wrinkle any drawing paper under ordinary conditions. When making changes on these drawings a great saving of time comes in over tracing cloth. The pieces or parts to be changed are cut out and a new piece is pasted in and redrawn. The draftsmen soon get so expert at this that a piece 1½ inches square can be cut out and pasted in in less time than it could be erased on tracing cloth. The piece to be changed is first squared off and cut out with a knife. This is then laid over another piece 3-32 or ⅛ inch larger than the piece that has been cut out and the edges are glued all around with ordinary library paste; it is then pasted on the reverse side of the drawing. Fig. 11 shows an interesting case as far as the number of patches is concerned. Of course the blue-print will be rather light

* R. F. Kiefer, Sharon, Pa., April, 1906.

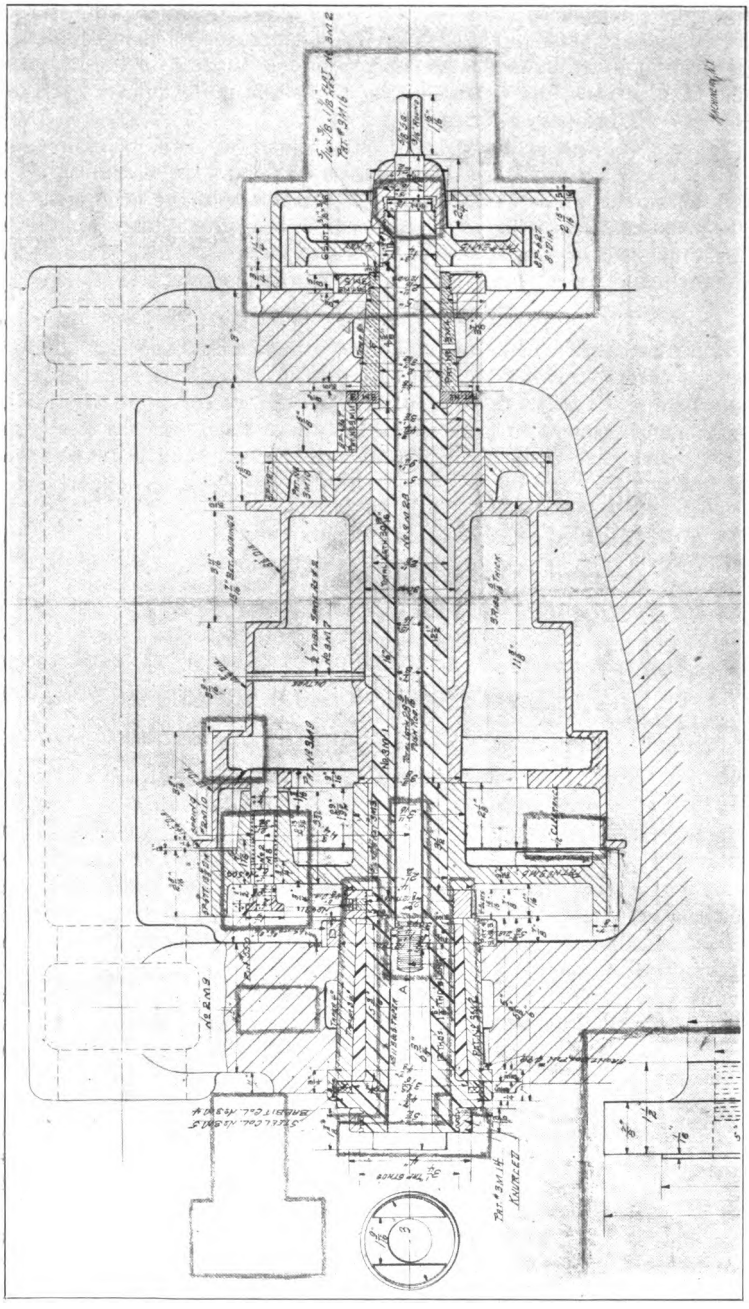


Fig. 11. A Patched Bond Paper Drawing.

around the edges of the patch, but this only indicates to the shop where the changes have been made, and is rather an advantage than otherwise. The engraving, Fig. 11, referred to, is a half-tone reproduction of a discarded drawing on bond paper patched in several places from time to time as changes were made. The work is so neatly done that it is scarcely discernible save when held between the eyes and the light. For this reason the patched effect would not be apparent in the cut, so each patch is penciled around the edge, the penciling being about the same width as the lap, which is only about 1-16 inch in most cases.

Another method used in another large drafting-room engaged in machine tool design, in which, also, bond paper drawings are largely used, deserves attention. Here, when drawings have to be patched, a sheet of clean paper is laid under the affected portion, which is removed by cutting with a sharp knife. The knife passes through both sheets of paper, thus providing a patch to fill the opening at the same time. To fasten this to the main body of the drawing, a piece of transparent paper spread with clear mucilage is used, if the patch is small. If of considerable size, the joint is neatly covered with thin strips of gummed transparent paper about ⅛ inch wide.

The advantage of this method is the smoothness of surface produced. The patch is flush with the main body of the drawing paper and the drawing instruments pass over the joint between the old and new portions without difficulty. It would be especially useful in cases where alterations are made on thick drawing paper. When neatly done with a sharp knife, the joint in such cases is almost invisible. The writer has employed it on tracings, where it worked very well, although it has been found that ordinary library paste is not permanently effective in making the joint. A good clear mucilage should be used.

CHAPTER III.

DRAFTING-ROOM KINKS.

Ink bottle holders of various designs are constantly appearing in the technical press, and are always of interest to draftsmen. Two typical designs are here shown, which will be found to answer the requirements for serviceable ink bottle holders. The one shown in Fig. 12 is made for a Higgins drawing ink bottle, and is cheap, easy to make, light and neat, and will not tip over easily. This construction does away with toothpick wedges and strips of paper to keep the bottle tight. The round piece fitted in the bottom is held with four No. 4 wood screws, one inch long. If the bottle does not fit tightly,

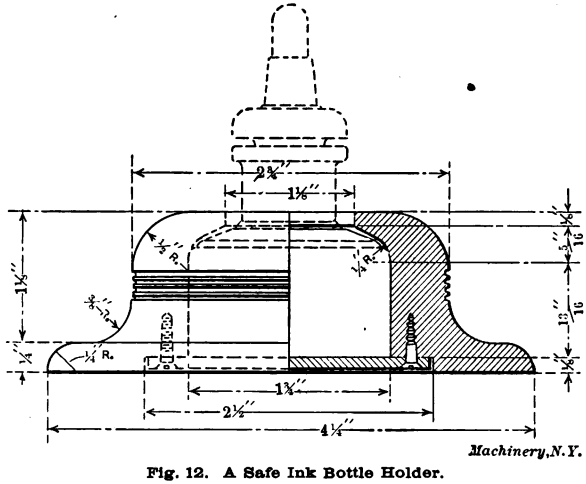


Fig. 12. A Safe Ink Bottle Holder.

put a piece of card underneath. Any pattern-maker can turn out a holder of this description in a short time, and with a coat of shellac it makes a very presentable appearance. The straight grooved sides make it easy and safe to handle. Three or four ¼-inch holes in the bottom, with old lead-pencil rubbers forced in, will make it non-slipping.*

Fig. 13 shows another type of ink bottle holder, used to advantage in some drafting-rooms. This serves a two-fold purpose, *i. e.*, to prevent spilling the ink, and also as a paper weight, which explains the thickness of metal used in the construction. The wood screws are screwed down just tight enough to make the heads a good sliding fit on the flange of the brass case, and when it is desired to remove the bottle, the case is slipped around until the heads of the screws come

* D. C. Turnbull, Mishawaka, Ind., September, 1905.

into the large diameter holes, when the case can be removed from the oak bottom.*

Re-rolling Tracing Cloth to Prevent Curling.

A problem all, or nearly all, draftsmen are troubled with is the curling up at the edges of tracings, when filed away in drawers. It

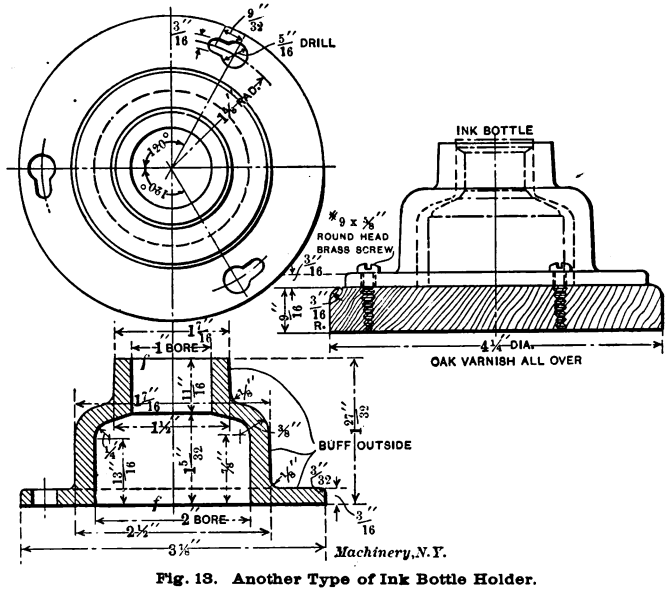


Fig. 13. Another Type of Ink Bottle Holder.

seems almost impossible to make them lie flat, and when put into the printing frame, the edges get folded down and make bad-looking edges on the print. Not very many draftsmen like to use the dull side of the tracing cloth, although the drawings made on this side will keep

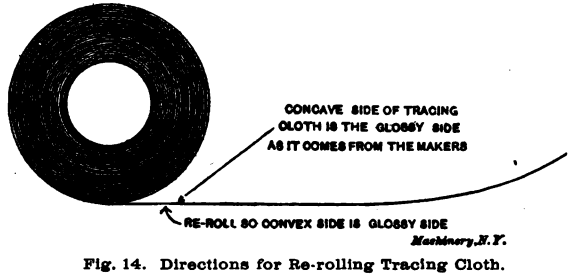

CONCAVE SIDE OF TRACING CLOTH IS THE GLOSSY SIDE AS IT COMES FROM THE MAKERS
RE-ROLL SO CONVEX SIDE IS GLOSSY SIDE
Machinery, N.Y.

Fig. 14. Directions for Re-rolling Tracing Cloth.

flat much better than when the glazed side is used. The trouble with this curling up of the cloth is due to the fact that when manufactured, the cloth is rolled with the glossy side as the concave side, as shown in Fig. 14, which, of course, makes it curl. To overcome this, re-roll the cloth, putting the dull side in, and leave it lying for a month or

* W. O. Moody, Chicago, Ill., June, 1906.

so before using. It will be found that there is a great improvement, and that the drawings made on the glossy side are now curled down on the edges rather than up. If one should make some sort of a rewinding device for that purpose, it would be found to be worth the trouble.

Celluloid Templets.

A very handy templet for drawing small curves and circles, where great accuracy is not required, may be made with a piece of thin

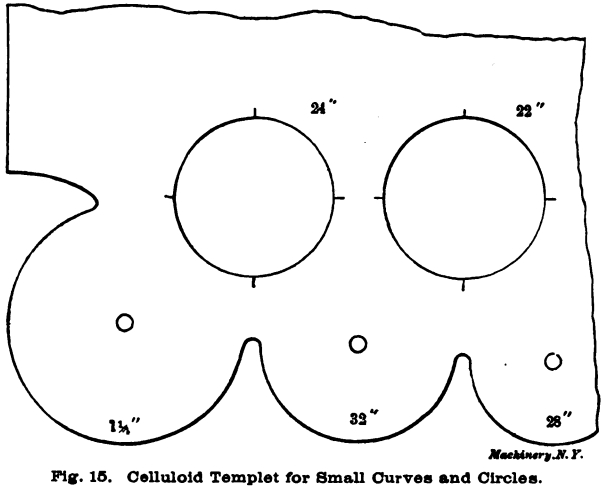


Fig. 15. Celluloid Templet for Small Curves and Circles.

celluloid. The templet, Fig. 15, is about 0.01 inch thick, and is a dark red tint, which is preferable to white. The circles are scratched deeply with bow dividers on one side, the center pushed through, and the same done on the other side until the piece can be broken out. By lightly scratching the center lines just beyond the outside of the circle

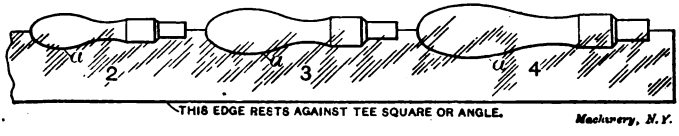


Fig. 16. Templet for Machine Handles.

before the center is removed, the hole can be located on center lines. On the edges, and particularly at the corners, are parts of circles with the center left and enlarged enough for the pencil point to go through to mark it. Sizes may be indicated by numbers giving the thirty-seconds of inch diameter. The holes should be cut slightly large to allow for the pencil point; outside curves, slightly small for the same reason. Similar templets may be made for the irregular shapes which are much used.*

* E. W. Beardsley, Waterbury, Conn., September, 1905.

Templet for Drawing Machine Handles.

The drawing of machine handles may be facilitated very much by the aid of a celluloid templet as shown in Fig. 16. If there is a forming tool for each size of handle it is an easy matter to make the templets, and thereby have the drawings the same outline as the formers. If filed out, the outline *a* of the lower half of the handles is scratched on the templets and is filled in with black wax.

Templet for Drawing Nuts and Bolt Heads.

A very handy templet for drawing nuts and bolt heads can be made as shown in Fig. 17. It is made of thin transparent celluloid and facilitates what is perhaps the most commonly repeated work to be done on a drawing. Lines are ruled on the templet, which, when

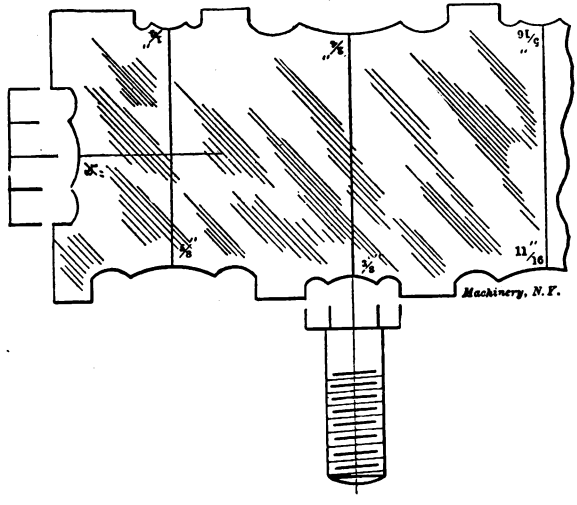


Fig. 17. Templet for Nuts and Screw Heads.

used, are placed over the center line on the drawing, and the curved outlines can then be drawn.

Erasing Shield.

As an erasing shield nothing is equal to a very thin piece of sheet steel with slots cut with a small cold chisel and filed smooth. It should be about 0.003 thick. The slots will not wear perceptibly large during many years of use.*

A Celluloid Protector for Drawings.

It is a well-known fact that in laying out and designing any mechanism of a complex nature several erasures occur which roughen the surface, and the paper then becomes dirty much quicker than otherwise. Assuming that the upper right or left corner of a sheet has a side view which has been worked on for several days, and it is now required to draw a front view of the same object, it is, of course, neces-

* E. W. Beardsley, Waterbury, Conn., September, 1905.

sary to transfer the center lines, make comparisons, take off measurements, etc., from the side view, and for this reason it is certainly proper to have the side view constantly in sight.

To cover the part already finished with a piece of paper is all right in its way and is better than nothing, but it is annoying to always have to lift the paper covering in order to see the sketch. This trouble may be overcome in a very simple manner; the covering consists of a sheet of celluloid (the thinnest transparent, about 0.010 inch thick) which will cover one-half of the drawing. The price of such a sheet, in this case about 12 × 18 inches, is only 50 cents, and it will save its cost over and over again. It is self-evident that by using this sort of shield the T-square in sliding across the sketch covered cannot injure it, and furthermore, if the celluloid is bent at its lower edge as indicated in Fig. 18 and a single thumb tack used at the upper end it is an easy matter to shift the shield from left to right or *vice versa*. If it should be necessary to get at both views occasionally it is not even necessary to remove the tack; simply lift the T-square and swing the celluloid shield so it hangs down from the back of the drawing board.

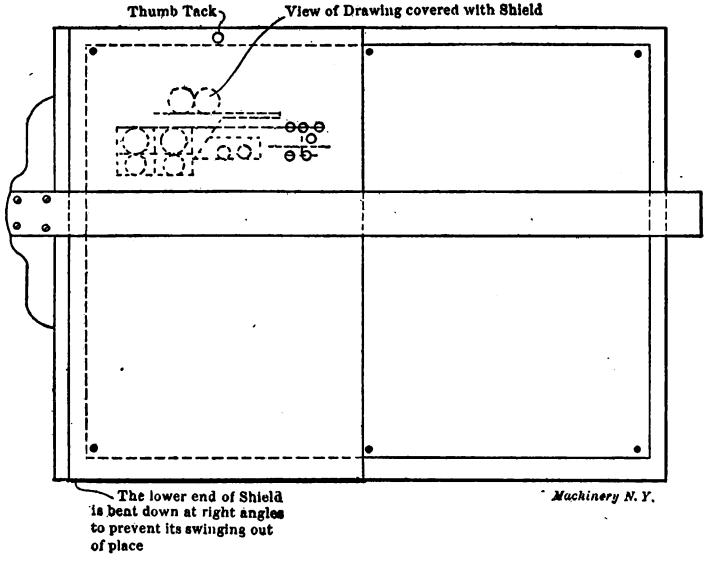

Thumb Tack
View of Drawing covered with Shield
The lower end of Shield is bent down at right angles to prevent its swinging out of place
Machinery N. Y.

Fig. 18. Celluloid Protector for Drawings.

It is a pleasure to work on a drawing with a shield of this description as the lines can be seen practically as well through the shield as if it were not there; likewise measurements can be very readily taken off.*

Hanger for Reference Drawings.

It is very often that a draftsman is required to use another drawing for reference which he must continually consult, and if it is a large

* Robert A. Lachmann, Chicago, Ill.. May, 1906.

sized drawing it is generally kept on the consulting table beside his drawing board. This compels him to keep forever stretching to see it or constantly getting on and off his stool. The following scheme will prove very useful for avoiding the difficulties referred to.

Fig. 19 will make the device clear without much explanation. *A* is a pine stick ⅜ inch by 1½ inch and about 40 inches long. Onto this stick are screwed three ordinary spring clothes pins. Two strings are fastened to the stick and pass up to two screw-eyes placed in the ceiling the same distance apart as the strings on the stick. Two more screw-eyes are placed in the ceiling near the wall, or any out-of-the-way place, and through these the strings pass down to a weight. The holder is placed parallel to the drawing board, about one inch back of it, and holds the drawings where they can be easily referred to by the drafts-

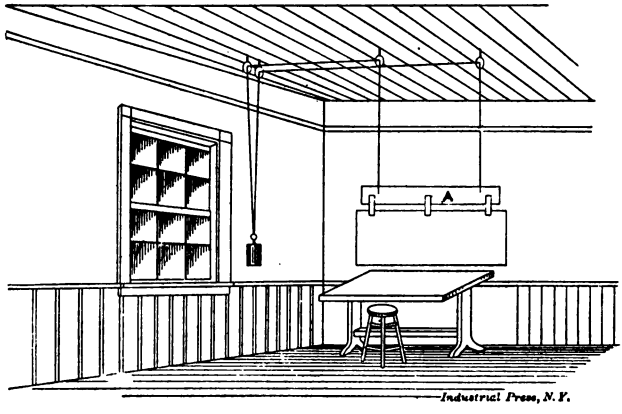


Fig. 19. Holder for Reference Drawings.

man at the same time as they can be raised or lowered to suit his convenience.*

A Time Saving Drafting Kink.

A great saving in time, which even well systematized drafting rooms seem to overlook, can be effected by putting one or two tracers to work cutting up a quantity of standard sizes of tracing cloth, drawing the border lines around them, stamping them with the standard marking, simply leaving out the name of the piece, date, and draftsman's initials, which, of course, are filled in when the tracing is made. This saves every man going and cutting up a piece of tracing cloth each time he is to make a tracing. It makes it very convenient for the tracers, as they can get the size sheet they want, tack it down, and trace in the drawing right away, without bothering with cutting to size, measuring the outline, and putting on the borders and title stamp. This plan also saves a great deal of waste of tracing cloth.**

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* Ernest W. Duston, November, 1902.

** F. L. Engel, New Britain, Conn., February, 1908.

Shading Drawings.

The time required in the drafting room to make simple shade lines to indicate the lower and right-hand edges of solids is time well spent. When a drawing is properly dimensioned, every distance that the workman will need to know being given, there can be no objection to such shade lines other than the time required to make them. The time dwindles into insignificance when the clearness and attractiveness of drawings properly shaded is taken into account. The drawing that possesses snap and life is an inspiration, and it is a real pleasure to work from it. The unshaded drawing has a weakness and dullness that is discouraging. It requires more mental effort or concentration to understand it, and the chances for error of interpretation are greater than with shaded drawings. Shade lines for rounded surfaces, however, are not generally desirable. Unless such shading is *very well* done, the result is decidedly amateurish in appearance. If it is well

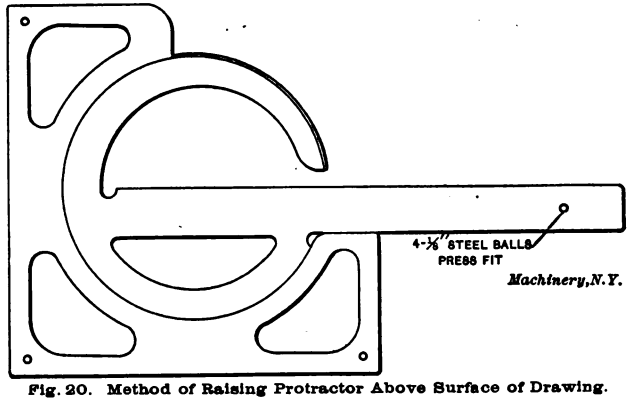


Fig. 20. Method of Raising Protractor Above Surface of Drawing.

done the effect is, of course, pleasing and the subject stands forth clearly, but unless for some very special cases, it should not be favored.

Raising Draftsman's Protractor Above the Surface of the Drawing.

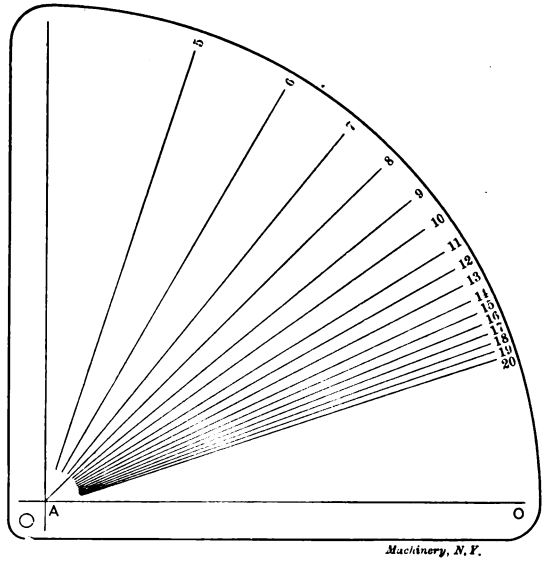
Anyone who uses a Brown & Sharpe draftsman's protractor is familiar with the way it soils the drawing, when put to any extended use, in spite of the utmost care on the draftsman's part. Fig. 20 shows a good scheme for raising the surface of the protractor slightly from the drawing. Four steel balls are made a press fit in the device at about the positions shown, the balls being about ⅛ inch diameter, projecting an equal amount on both sides, thus giving the same results no matter which side of the instrument is up. This addition to the instrument in no way affects its accuracy, and, as the balls bear only on four points, they rub less dirt into the drawing than an ordinary triangle.*

Tool for Spacing Bolt Holes.

In drawing flanges, cylinder heads, etc., where a number of holes are shown on a given pitch circle, it is usually desirable to have them lo-

* M. R. Kavanagh, Detroit, Mich., January, 1908.

cated correctly on the drawing, for the sake of appearance at least, even if not really important otherwise, and for this purpose the tool shown in Fig. 21 was designed. It is a very convenient instrument, made from transparent sheet celluloid, about 1/64 inch thick. The method of procedure when using this tool is to draw the pitch circle, and then place the instrument over it, with the point *A* on the center. One point of the dividers is placed on the line *A O*, at the point where it intersects the pitch circle, and the other point of the dividers is set at the intersection of the pitch circle and the radial line marked with a number corresponding to the required number of holes in the whole pitch circle. This gives the correct spacing for the number of holes required. If reasonable care is used in the construction of this tool, it will be found to give very close results. The design, of course, can be varied to suit special requirements. The one shown in Fig. 21 was



Machinery, N.Y.

Fig. 21. Tool for Spacing Bolt Holes.

made by laying off the correct angles on the circle having 18 inches radius, and scratching the radial lines with a needle point on the celluloid, after which drawing ink was rubbed into the scratches so as to make them show plainly.

Drafting Tool for Sketching Ratchet Teeth, Etc.

Fig. 22 shows an extremely useful little drafting tool which any mechanic can make in a short time. One can use the slotted blade from a Starrett universal bevel (the blade which has the ends beveled to 30 and 60 degrees), also the clamping screw and nut. The other part is made from a piece of 3/4 × 1/16 inch cold-rolled steel and a piece of 1/4 inch drill rod. It is used for drawing ratchet teeth or any

similar work. If one has the time, a chuck or clamping device for holding a needle point might be made instead of the solid stem and

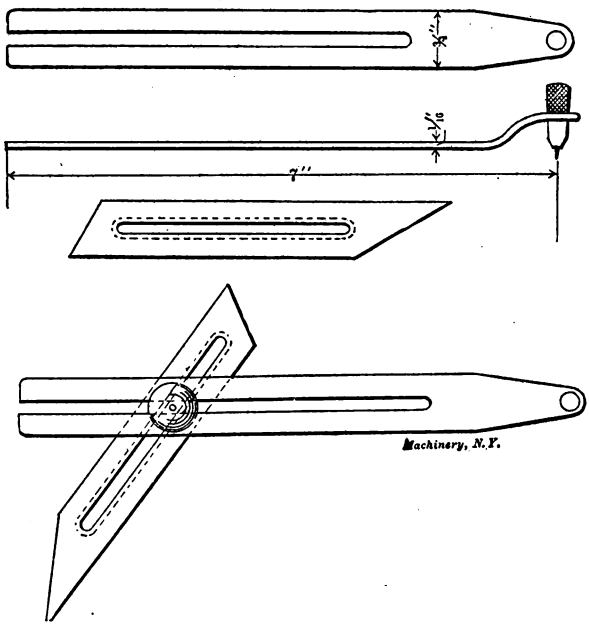


Fig. 22. Drafting Tool for Ratchet Teeth.

point shown. The bevel, without this attachment, is quite handy in drawing as well as machine work.

Simple Device for Drawing Elliptic Curves.

Fig. 23 is a simple device for drawing elliptic curves which is not without interest and value. It has the merit of being quickly adjusted

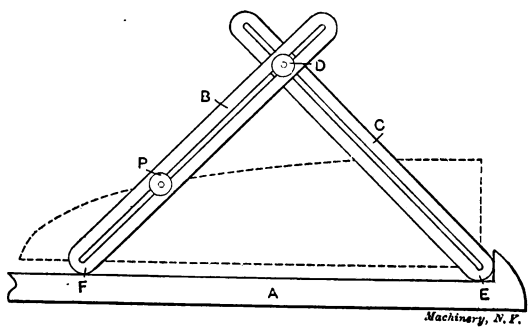


Fig. 23. Device for Drawing Elliptic Curves.

for any required major or minor axes within the limits of the instrument, but has the defect that only one-quarter of the ellipse can be drawn at one setting. *A* is a straightedge with a stop or projection at

E. *B* and *C* are slotted rods, each having the lower ends truly rounded to perfect semi-circles for the obvious reason that any other shape would distort the shape of the curve. The rods are held together by a joint similar to that used in proportional compasses, that is, the joint may be fixed on the bars in any required proportion, and still allow them to swing on the joint as a pivot. At *P* is the holder for the pencil or scriber, and this also is adjustable in the slot. When drawing an ellipse, the distance *FP* is made equal to one-half the desired minor axis, and *PDE* must be made one-half the length of the major

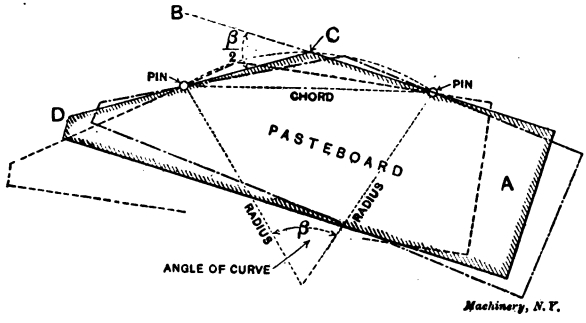


Fig. 24. Plotting a Circular Arc having an Inaccessible Center.

axis. Fig. 23 shows clearly how the curve is drawn, and it will be noted that a short section of the quarter ellipse must be drawn in

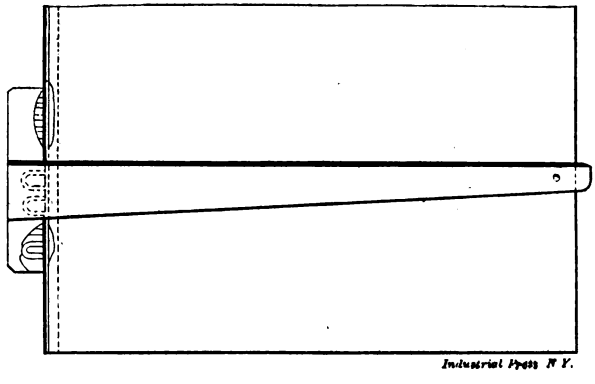


Fig. 25. Magnetic T-Square Attachment.

free-hand, since the pencil at *P* will interfere with the bar *C* when near to the vertical position.

Method of Plotting Curve from Inaccessible Center.

Two pins are stuck into the drawing board at the end of the required curve, and a piece of pasteboard, *A*, Fig. 24, is cut so that the exterior angle *BCD* is one-half that of the required arc. Thus, if the angle subtended at the center is 40 degrees, angle *BCD* would be 20 degrees. To lay off the curve, the pasteboard is pressed against the pins, as shown

in the sketch and the points of the curve are marked off from vertex *C*. The shade lines show the position of the pasteboard templet, and the dotted lines, other positions that it occupies as the points are laid down.

Drawing Board and T-Square with Magnetic Attachment.

An English novelty in drafting room appliances, shown in Fig. 25, is a T-square having a number of small horseshoe magnets mounted in the head and so arranged that their poles come in contact with an iron strip attached to the left-hand end of the board, the idea being to hold the T-square to its right-angle position, by magnetic attraction alone. This, of course, allows the draftsman to use both hands at his work more advantageously. The magnets are said to oppose little resistance to movement of the blade to any position parallel with its normal position, but considerable force is required to displace the blade from its right-angle position. A drawing board with this attach-

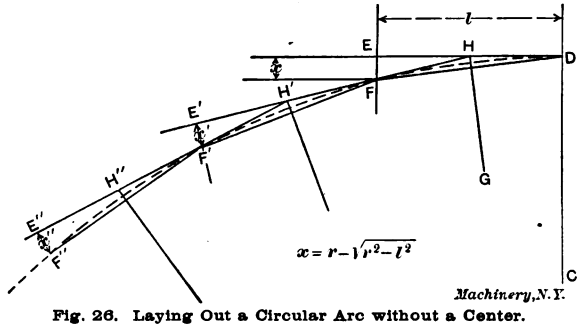


Fig. 26. Laying Out a Circular Arc without a Center.

ment may be used in a vertical, sloping or horizontal position with equal facility.

To Construct a Curve by Points.

Fig. 26 and the accompanying description will be found useful for laying out a circular curve having an inaccessible center or one whose radius is too long to be accommodated on the drawing-board. When the radius r is given, and any cord l is assumed, to construct a curve by points, proceed as follows: First find x by formula in Fig. 26. Draw line *CD*, and at right angles to it the line $ED = l$. Through *E* draw the perpendicular *EF*, and make it equal x (marking the first point in the curve) at *F*. Join *FD* and bisect it in *G*; through *G* draw the perpendicular *GH*, intersecting the line *ED* in *H*, and through *F* and *H* draw the indefinite line *HFH'E'*, making *FE'* equal to *l*. Erect the perpendicular *E'F'* equal to x, and locate *F'*, which is the second point of the curve; proceed in the same manner for other points of the curve desired.*

Stamping Tracings.

To stamp names or headings on tracing cloth, use a rubber stamp with the ordinary red, blue or green ink found in ink pads. Before

* Geo. H. Waltman, Hokendaugua, Pa., December, 1899.

the ink has a chance to dry, sprinkle lamp-black over it, using an insect powder sprayer for the purpose. When dry, brush off with a piece of chamois skin. Stamping done in this manner will be found light-proof.

Pencil Sharpener.

Fig. 27 represents a pencil sharpener or pointer. As seen from the illustration, it consists of a piece of thin spring brass bent to the form shown and fastened under the table near the edge by two round-head wood screws. The sandpaper is held between the table and the brass spring. To sharpen the lead of the pencil, slip the point between the leaves of the sandpaper and move it back and forth.*

Making Blue-Prints Without a Frame.

Blue-prints of small size can be made fairly conveniently without a blue-printing frame. An ordinary window can be used if the sun shines through it, and a blue-print can be made in any window. An ordinary thick bath towel is placed behind the print, the tracing being placed against the glass. The towel should be folded into two or three thicknesses and arranged so that no wrinkle or uneven part lies against the print. A small drawing board may then be placed against the towel, but it is better to tack the towel at its corners to the board.

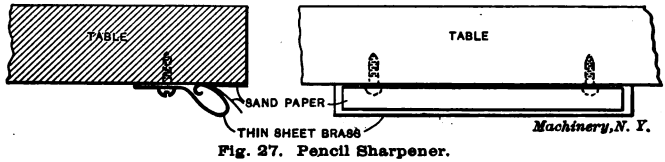


Fig. 27. Pencil Sharpener.

It is also advisable to attach the tracing to the printing paper by small gummed stickers, to keep them in the proper position and to prevent sliding. Ordinary stickers cut into narrow strips will be sufficient, and need engage only a narrow surface on both the paper and the tracing, to serve the purpose. The print can then be frequently looked at without disturbing the relation, and can be easily torn off without injuring it or the tracing. Fragments of the stickers are easily scraped off. The printing paper and tracing can be held by a blank projecting edge against the window while the towel and board are being pressed against them. Any suitable means for holding the board in place may be used.

Another improvised printing outfit used by the writer consists simply in spreading the towel evenly upon the floor where the sun can strike it, placing the printing paper and tracing upon it, and then merely covering these with a thick plate of glass. When first laid down, the glass may be pressed downward with considerable pressure, after which its weight alone will be sufficient to keep the paper smooth. This will be the case if two or three thicknesses of bath towel are used. This plan works perfectly for sheets 10 × 15 inches and below. Larger prints could doubtless be made in this way if weights were put upon the corners of the glass.

* John B. Sperry, Aurora, Ill., October, 1908.

Another very practical way of making small prints is to use a smooth board with a slightly curved face. A tack placed in each corner of the tracing and print will cause them to snugly lie against the curved surface of the board, making a sharp and clear print. No glass is needed.*

A Blue-Printing Kink.

In the winter months it is hard to judge the time required to make sunlight blue-prints, and it is a very good idea to make a scale of colors with which to compare a test piece of paper. Take a piece of blue-print paper four inches wide and ten inches long. Cover all but one inch with a heavy piece of paper. Expose this one inch for say one minute in a mild light, then move the cover so as to expose one inch more for one minute, which exposes the first inch two minutes, and so on, inch by inch, until all ten inches have been exposed, and the first division has been exposed ten minutes, which in this light, for instance, produces a perfect print. Now wash the paper thoroughly, and when dry you have a scale with which to compare

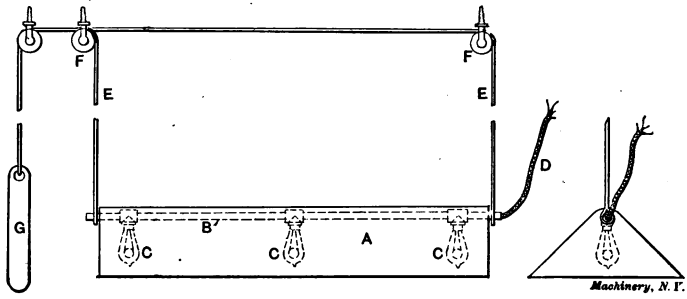


Fig. 28. Adjustable Light Holder for the Drafting-Room.

other prints. Figure out the relative times that would have been required to bring each color to a perfect blue-print, by dividing the whole time by the time exposed, and mark this number on the color, this number to be used as a multiplying factor. Now, in order to get a perfect print, put out the tracing you wish to copy with a small piece of blue-print paper, and leave it, say two minutes, until it would be printed some, but not enough. Then wash, dry with blotters and compare with the scale sheet. Say it was like the fourth color from the bottom. The factor would be 2½. Multiplying this by the two minutes equals five minutes, the time required to make a perfect print in that light. I am pleased with the uniform results obtained.**

The Lighting of Drafting-Rooms.

The lighting of drafting-rooms is a subject often discussed without reaching a satisfactory conclusion for all cases; each one must necessarily be governed by local conditions. The apparatus described in the following is cheap and efficient, and for artificial illumination, when

* C. E. Burnap, Battle Creek, Mich., September, 1908.
**Austin G. Johnson, Two Harbors, Minn., November, 1908.

electricity is to be used, has proved to be entirely satisfactory in actual practice. Referring to the illustration, Fig. 28, the shade *A* was made of tin, painted dark green outside, and white inside, through which was passed a pipe *B* with T-connections at lamps *C*. The wires *D* were drawn through the pipe and connected with ordinary 16-candle-power incandescent lamps which were fastened at these T-connections. The whole thing was suspended from the ceiling by cords *E* drawn

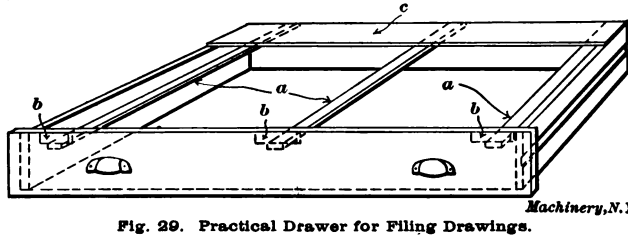


Fig. 29. Practical Drawer for Filing Drawings.

over pulleys *F*. The cords were attached to the counter-balance *G*, and to the shade as shown, allowing the lights to be raised entirely out of the way when not required, or lowered directly over each board sufficiently to shield the eyes of the draftsman and reflect the light over the entire board. The length and number of globes will, of course, depend upon the length of board.

This arrangement may be modified to meet the requirements of the more refined tastes willing to pay for elaborate furnishings. How-

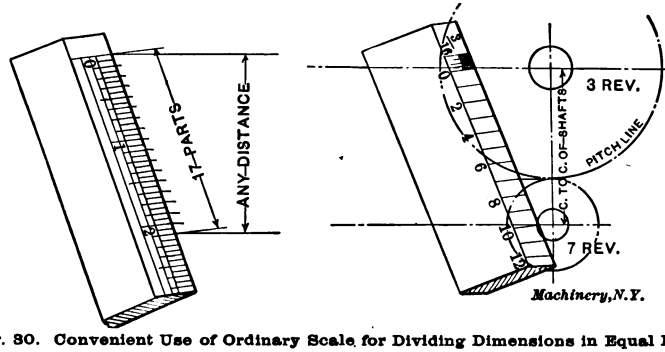


Fig. 30. Convenient Use of Ordinary Scale for Dividing Dimensions in Equal Parts.

ever, the leading features should remain the same: A suspended individual light of wide range, adjustable for height, while permitting the full swing of beam compasses or drafting machine, without encountering supporting brackets. It casts no shadows and protects the eyes of the worker at the board.

Drawer for Drawings.

A simple and cheap method of making drawings lie flat in drawers is shown in Fig. 29. It consists of three blocks *b* fastened to the inside of the front of the drawer, a back top *c*, and three slats *a*, which are slipped in under *c* and *b*. These slats keep the drawings from

curling up and catching in the drawer case. By using a drawer of this description, the capacity is increased from three to four times.*

The Use of the Ordinary Rule for Dividing.

The operation of dividing a line into any number of equal spaces is a very simple one, and one of the first exercises in geometry, but however familiar men might be with its execution, one rarely uses the rule for this purpose. When it is required, for instance, to draw a certain number of lines or a certain number of threads per inch, in a given space, sometimes the length of the single spaces will be figured, or a diagonally drawn line will be spaced off with the dividers and the spaces transferred with the triangles.

The shortest way is to use the ordinary or draftsman's scale. Use the graduation, nearest suitable to the eye, place the zero mark on one end of the space to be divided, and the number corresponding to the parts required on the line marking the end of the space, or its continuation, mark off points at every graduation, and with triangle or T-square draw parallel lines through these points, as shown in Fig. 30. At the left is shown two lines, the distance between which is to be divided into 17 equal parts. In this case the regular scale of an ordinary rule is used; after the points are marked off, parallel lines are drawn

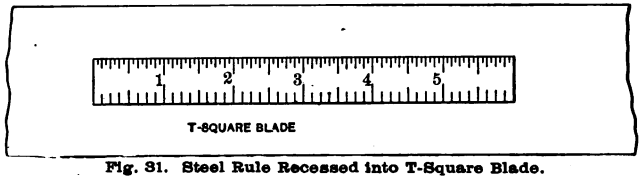


Fig. 31. Steel Rule Recessed into T-Square Blade.

through them. This use of the rule for dividing without going to the trouble of figuring is applicable in a great number of cases. The distance center to center of two shafts is given, and a transmission of spur gearing of the ratio 3 to 7 between them is wanted. The pitch circles can be drawn immediately without figuring their diameters or number of teeth. Draw the distance between centers to scale, hold the zero mark of rule on a line through one center and the graduation 10 (= 3 + 7) to a parallel line through the other center; the graduation 7 marks the line tangent to the two pitch circles, as illustrated in the right-hand view.**

Steel Rule Recessed into T-Square.

The following little kink may be of some value to draftsmen. A 6-inch flexible Brown & Sharpe scale is laid into the T-square blade, which has previously been recessed somewhat to fit the scale, as shown in Fig. 31. Shellac is used to hold the scale in place in its recess. The dividers and compasses may be set directly from this scale, and the annoyance of looking for an ordinary loose draftsman's scale is avoided. Scales graduated to 32ds and 64ths of an inch are convenient for fine work.***

* John B. Sperry, Aurora, Ill., July, 1908.
** M. Joachimson, New York City, July, 1908.
*** John Coapman, Rochester, N. Y., June, 1908.